Hindawi Publishing Corporation
Journal of Computer Networks and Communications
Volume 2013, Article ID 897029, 2 pages
http://dx.doi.org/10.1155/2013/897029

*Editorial*

# Energy-Efficient Wireless Communications with Future Networks and Diverse Devices

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Received 11 February 2013; Accepted 11 February 2013



Telecommunication networks are responsible for approximately 2% of the global energy consumption. As data traffic continues to grow due to the proliferation of smart phone devices, reducing greenhouse emission by improving the network energy efficiency is becoming increasingly important. Such improvements may be achieved by advanced system design at both the network and the mobile terminal sides, although the majority of savings may come from the infrastructure. For instance, one promising technique for cellular network power reduction is through advanced radio resource management (RRM) to dynamically switch ON or OFF a basestation based on daily traffic variation. By switching OFF lightly loaded basestation and offloading the traffic to neighboring basestations, significant energy reduction may be possible without compromising the network performance.

Improving energy efficiency also needs to consider future networks shifting towards more diversified services. Exemplary application scenarios include smart metering, wireless sensor monitoring, and machine-to-machine communication. These scenarios introduce new traffic behaviors in the network, and due to the smaller packet sizes and the extremely large number of devices, improving energy efficiency of the network while reducing device cost is vital. There is a need for energy-efficient solutions to enable new smart and energy-efficient devices to simultaneously share the network with relatively fewer numbers of conventional devices that have much larger data and energy consumption demands.

The goal of this special issue is to give a comprehensive overview of the ongoing research on energy-efficient wireless communication for future networks and devices, in areas including energy-efficient communication, smart metering, energy harvesting, energy conservation with network coordination, and machine-type communication. We hope that this will motivate interested researchers to explore and propose new ideas in these growingly important areas. The special issue begins with a paper coauthored by A. Shareef and Y. Zhu discussing a novel evaluation platform for assessing energy efficiency of wireless sensor networks. Such a model is important as it allows for quick and accurate evaluations of different energy consumption algorithms, protocols, and system designs. In particular, the article proposes a Petri net model-based platform, which is analytically and numerically shown to outperform the Markov model and programmed simulation in terms of evaluation accuracy, with low construct and test simplicity.

In the article coauthored by A. Chehri and H. Moutfah, the researchers go into more details on improving the energy consumption efficiency of wireless sensor networks. As sensor nodes are usually powered by batteries or other low-energy power resources, optimizing the system performance with power constraint is of practical importance. For that end, the authors propose a green routing protocol relying on adaptive modulation and power control, which is shown to improve the energy efficiency of sensor networks without compromising the QoS constraint of delay and error rate.

The paper coauthored by G. Chen et al. investigates a new routing algorithm for wireless sensor networks (WSNs) based on principal component analysis (PCA). By disclosing the connection between PCA and K-means, the authors design a clustering algorithm which efficiently develops a clustering structure in WSNs. Moreover, as a compression method, the paper demonstrates that PCA technique can also be used in data aggregation for WSNs. It establishes the explicit procedure of PCA-guided routing algorithm for WSNs by incorporating PCA technique into both the data aggregating and routing processes. The advantages of the proposed algorithm are demonstrated by theoretical analyses and simulation results. The simulation results show that the PCA-guided routing algorithm significantly reduces the energy consumption, prolongs the lifetime of network, and improves network throughput.

In the following article, A. Silva et al. study new power management techniques to extend as much as possible the lifetime of primary cells (nonrechargeable batteries). By assuming low duty-cycle applications, three power-management techniques are combined in a novel way to provide an efficient energy solution for wireless sensor networks nodes or similar communication devices powered by primary cells. Accordingly, a customized node is designed, and long-term experiments in laboratory and outdoors are realized. Simulated and empirical results show that the battery lifetime can be drastically enhanced. Unattended nodes deployed in outdoors under extreme temperatures, buried sensors (underground communication), and nodes embedded in the structure of buildings, bridges, and roads are some of the target scenarios for this work. Some of the provided guidelines can be used to extend the battery lifetime of communication devices in general.

M. N. Alam et al. investigate the energy consumption for the IEEE 802.11s link specific Power Saving Mode (PSM) for peer link operation. The study is further extended to a multihop network consisting of eight STAs. They conclude that at the cost of increased packet delay, the IEEE 802.11s PSM operation not only provides significant energy savings, but also provides almost the same throughput that the active mode operation offers. For a large network, the energy saving could be as high as eighty percent when compared with active mode operation. In the presence of hidden node especially, the PSM can perform much better than an active mode, if the nodes avoid simultaneous operation. Further it is also shown that, by switching to active mode, receiving STAs can reduce the link delay considerably, which points to a clear tradeoff of delay, throughput and energy consumption. The analysis provided can be used to investigate the critical parameters in PSM operation in an 802.11 network.

The paper coauthored by K. Dhondge et al. introduces an energy-efficient collaborative and opportunistic positioning system (ECOPS) for heterogeneous mobile devices. In particular, ECOPS-facilitates mobile devices with estimated locations using Wi-Fi in collaboration with a few available GPS broadcasting devices, in order to achieve high-energy efficiency and accuracy within available energy budget constraints. ECOPS estimates the location using heterogeneous positioning services and the combination methods including a received signal strength indicator, 2D trilateration, and available power measurement of mobile devices. The evaluation conducted by the authors shows that ECOPS significantly reduces energy consumption and achieves good accuracy of a location.

Energy consumption reduction in the receiver chain by limiting the use of the equalizer is investigated by S. Bourbia et al. This goal is achieved by making the radio receiver aware of its environment and being able to take decision to turn on or off the equalizer according to its necessity or not. When the equalizer is off, the computational complexity is reduced, and the rate of reduction depends on the percentage of time during which the component is disabled. In order to adapt the use of the equalizer, the authors developed a decision-making technique that provides to the receiver the capacities of awareness and adaptability to the state of its environment. A technique based on a statistical modeling of the environment is introduced by defining two metrics as channel quality indicators to evaluate the effects of the intersymbol interferences and the channel fading. The statistical modeling technique allows the authors to take into account the impact of the uncertainties of the estimated metrics on the decision-making process.

## Acknowledgments

The guest editors wish to take the opportunity to thank all the authors who have submitted their papers. We also wish to extend our thanks to the anonymous reviewers for their high-quality reviews which tremendously helped improve both the content and presentation of the papers in this special issue. Last but not least, we would like to thank the editorial board members for their valuable and insightful comments and guidance through the preparation of this special issue.

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